



Introduction

Welcome to Module MAC05, Accord Hybrid IMA Technology.

Module Prerequisites

Before starting this module, you should review the IMA Subject Area Map for any prerequisites.

Why This Module is Important

The Accord Hybrid uses the latest in Honda IMA technology, and differs in design from both the Insight and the Civic Hybrid.

This module will review basic IMA function, and define the differences between Accord IMA and previous models.



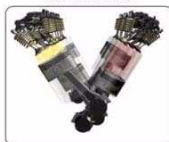
Objective

Upon completion of this module, you will be able to:

- Describe IMA components.
- Describe IMA system function.
- List unique IMA operating strategies.
- List the differences in each IMA generation.
- List the unique features to the two thousand five Accord Hybrid.

At the end of the module, you will evaluate what you learned about Honda IMA technology.

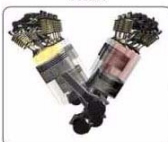
V6 & Assist



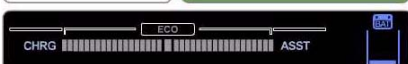
Acceleration



VCM



Cruise



System Overview

Honda IMA System

Honda Integrated Motor Assist systems have been designed to:

- Store energy in a high voltage battery.
- And use this energy to increase vehicle performance.
- Decrease fuel consumption.

These systems use a motor/generator to convert energy during vehicle operation, either by assisting vehicle acceleration, or generating electrical energy for storage.

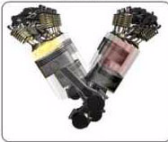
VCM & Assist



Light Acceleration



Assist w/VCM
& Fuel Cut



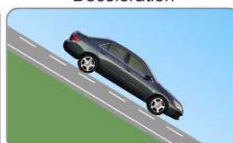
Light Load



Fuel Cut &
Generation



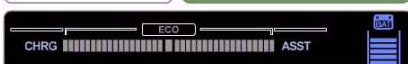
Deceleration



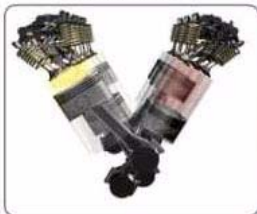
Idle Stop



Idle Stop



V6 & Assist



Acceleration



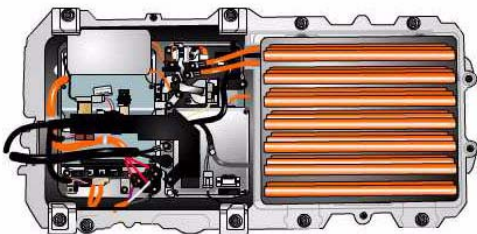
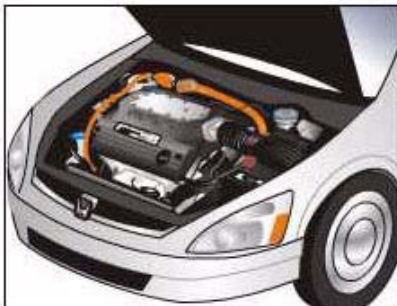
System Overview

Accord Hybrid

In addition, the Accord IMA system has new components to maintain climate control, and provide transmission line pressure during idle stop.

By installing these components, the Accord Hybrid increases the:

- Comfort of the vehicle passengers.
- Supporting climate control during idle stop
- And reducing driveline shock during start-up.



System Overview

High Voltage Safety

All Honda systems using a high voltage distribution system identify the presence of high voltage by using orange colored cables and covers.

In Honda systems, high voltage can come from the IMA battery, or may be created by the IMA motor when the engine is running.

Keep this in mind whenever servicing the high voltage system.

- There are specific service precautions and procedures used when working on an IMA high voltage system.
- Refer to the appropriate service manual for more information.



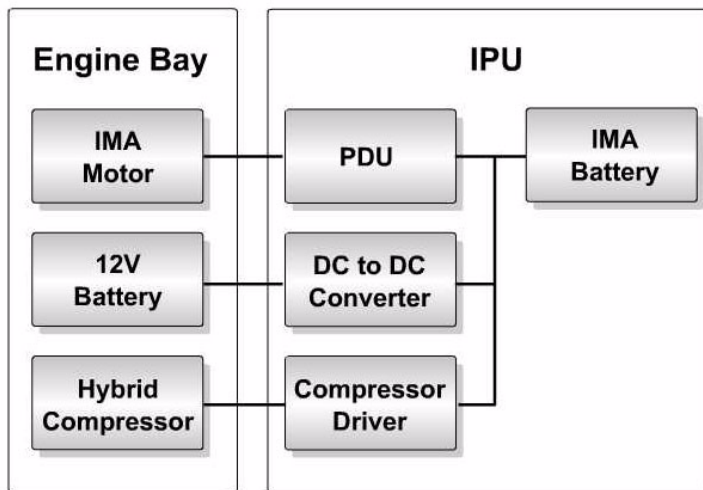
System Overview

IMA Meter

The IMA meter shows IMA system functions, and provides the driver with information regarding system activity.

- The meter displays bars in the assist section to indicate increasing levels of IMA motor assistance.
- The same type of display on the charge side of the display indicates IMA generation.
- In addition, a battery display indicates the battery State of Charge, or amount of stored energy.

IMA System



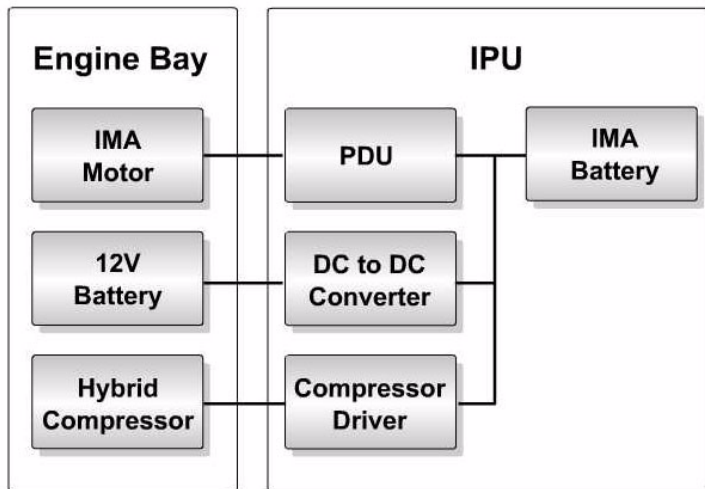
System Overview

IMA Functions

The Accord Hybrid uses new and existing systems to perform IMA functions.

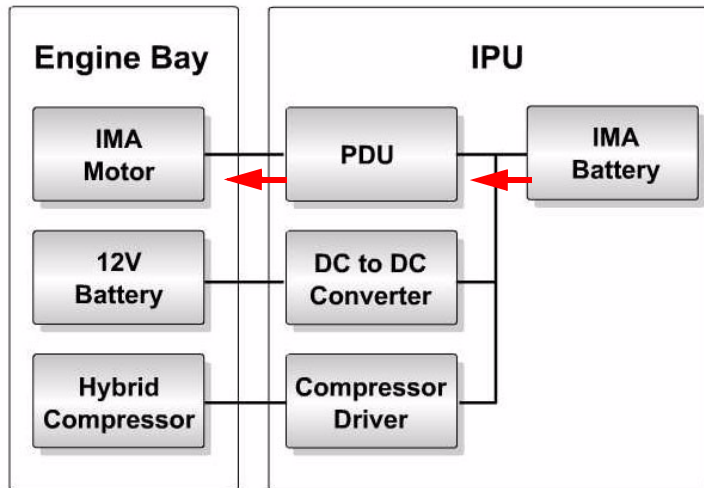
- Like the Insight and Civic, an IMA motor has been added to the driveline in order to both assist engine power, and generate high voltage electricity for all electrical loads.
- Like other Honda hybrids, the vehicle's 12 volt electrical system receives power from the IMA system, rather than using a traditional belt driven alternator.
- Unlike the Insight and Civic, the new Accord Hybrid includes an electric air conditioner compressor motor, designed to provide cabin cooling whenever conditions call for it's use.
- Behind the rear seat, an Intelligent Power Unit contains four systems. These systems store and distribute high voltage energy.

IMA System



- The Power Drive Unit oversees this energy distribution to the IMA motor, and controls the motor.
- The motor is used to assist the engine, or places a load on the engine to generate electricity.
- The DC to DC converter replaces the alternator, and converts high voltage electricity for use in the 12 volt system.
- Also new to Honda IMA systems, the hybrid compressor driver works in a manner very similar to the PDU, providing electricity to drive the air conditioning hybrid compressor motor.
- However, the AC compressor motor cannot be used to generate electricity.
- Finally, the IMA battery provides a place to store high voltage electricity for use when needed.

IMA System



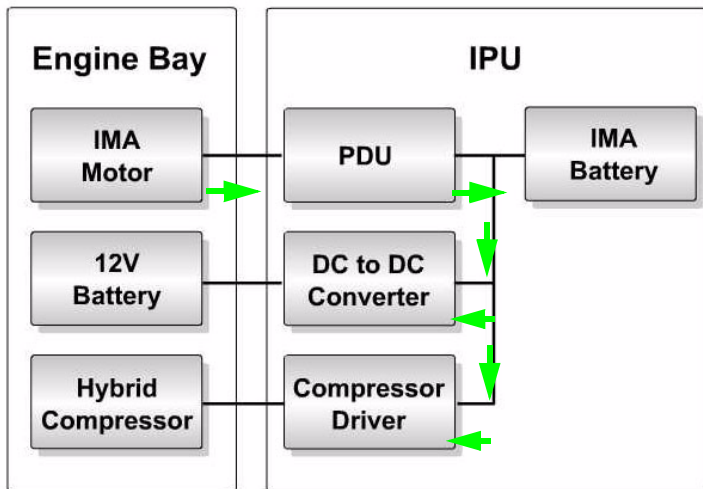
System Overview

Overview of IMA Function

During the assist mode of IMA system operation, energy from the battery is directed through the Power Drive Unit and into the IMA motor.

This energy flows from the IMA motor through the transmission, and increases the Hybrid Accord's available power.

IMA System

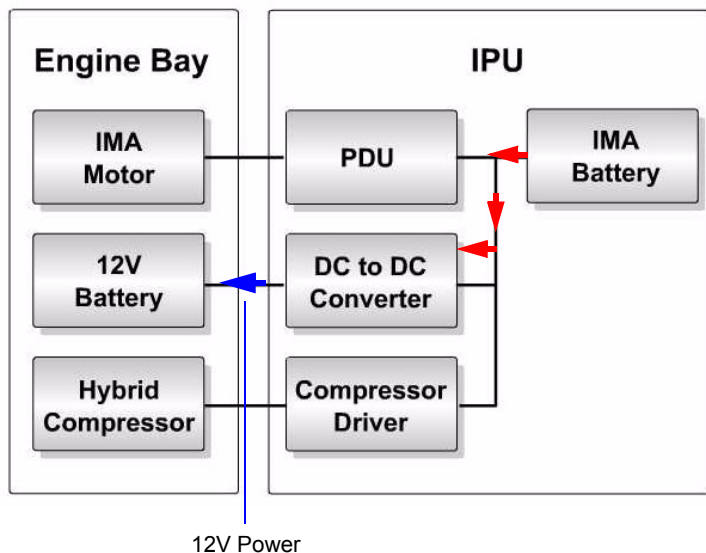


System Overview

Overview of IMA Function

The IMA motor can be used to generate electricity. During this mode, power from the IMA motor is directed through the PDU, and provides energy to the other high voltage systems, as well as recharging the IMA battery.

IMA System



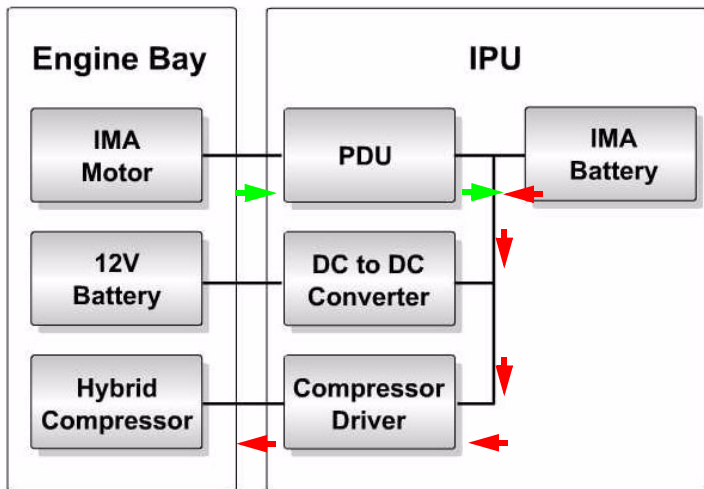
System Overview

Overview of IMA Function

Using electricity from the high voltage system, the DC to DC converter acts as an alternator for the vehicle, providing low voltage power for the car's 12 volt system.

As you may know, the Honda IMA system does not use an alternator to provide power in the traditional manner.

IMA System



System Overview

Overview of IMA Function

Finally, the Intelligent Power Unit contains an air conditioning hybrid compressor motor driver.

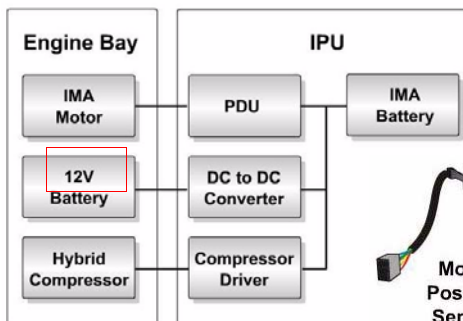
This electronic device uses high voltage DC, creating a high voltage power signal for the AC compressor electric motor.

In addition, the motor driver can vary motor speed as requested.



1st Generation

IMA System



2nd Generation

Rotor

IMA Hardware

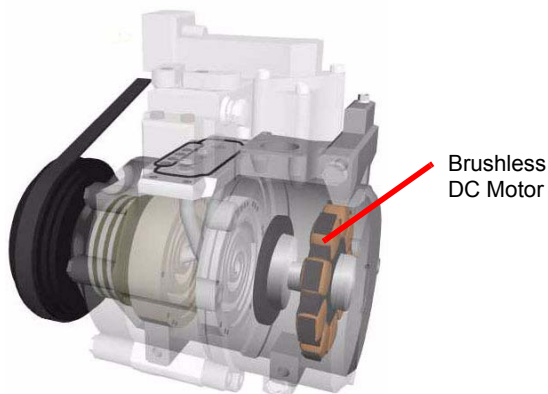
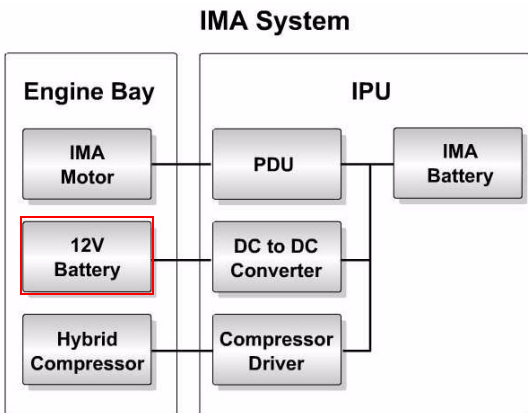
Under Hood

The Accord Hybrid includes traditional IMA hardware, as well as new technology designed to improve IMA system operation.

- Under hood, an IMA Motor Assembly provides starting, generation and assist functions, using a high voltage three phase brushless DC motor/generator.
- This motor is made up of a stator and electrical connections, mounted in the outer housing.
- A permanent magnet rotor mounted on the engine's crankshaft.
- A motor position sensor establishes rotor position for the IMA system.
- On earlier IMA systems, this function was provided by three discrete sensors mounted on the outer housing, but the Accord Hybrid mounts a single sensor assembly at the crankshaft.

Tech Note

Because of the rotor's strong magnetic field, use extreme care anytime the rotor requires servicing.



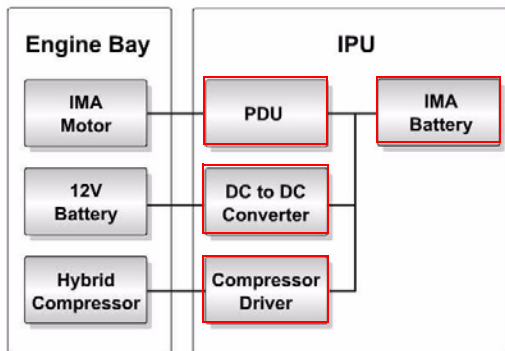
IMA Hardware

Under Hood (Cont.)

In addition to a traditional belt driven compressor, the Accord Hybrid also includes an electric motor driven compressor.

- This dual compressor design uses each side independently, which allows for greater cooling capacity, yet provides for better fuel economy over conventional compressors.
- The electrically powered side of the hybrid compressor uses a high voltage brushless DC motor, driven by the Electric Air Conditioning compressor motor driver in the IMA system.
- This motor operates using the same principles as the IMA motor, but is much smaller.

IMA System

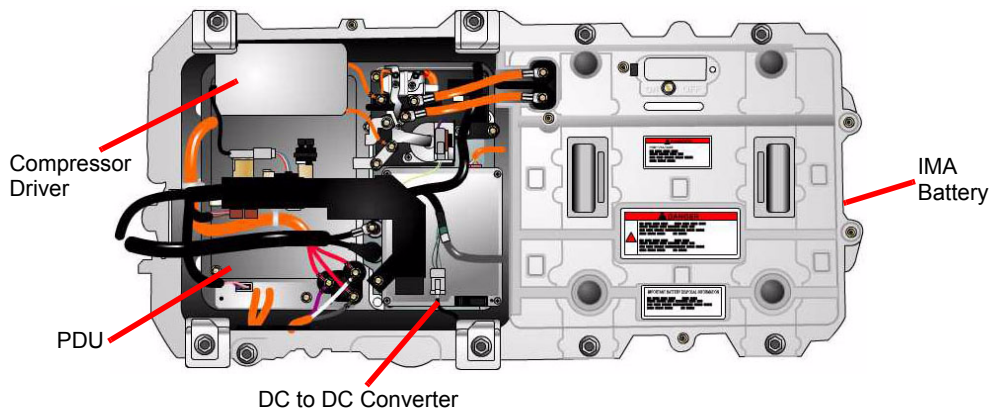


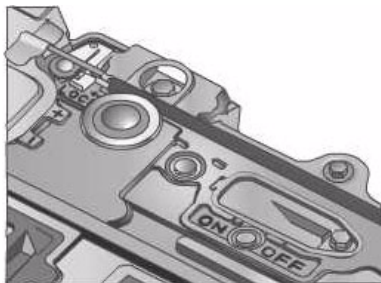
IMA Hardware

Intelligent Power Unit (IPU)

The Intelligent Power Unit contains two sections, each with a specific purpose.

- The IMA battery stores and releases energy as needed.
- The Power Control Unit directs the flow of power for the high voltage systems and sends power to the vehicle's twelve volt electrical system.





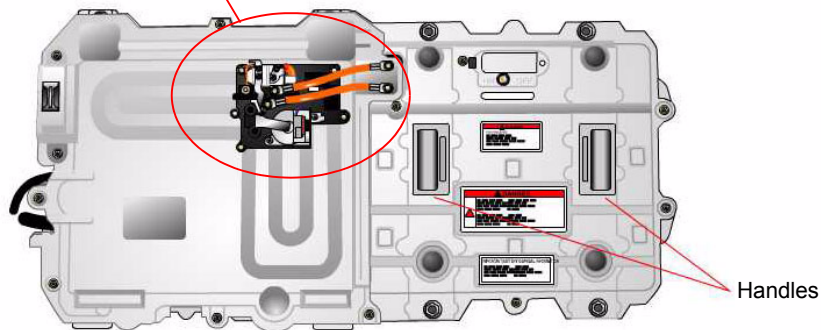
IMA Hardware

Intelligent Power Unit (IPU)

The IMA battery includes one hundred twenty cells in a battery pack, along with a disconnect switch and a system fuse.

- Built into the battery pack are temperature sensors for use by the IMA system, as well as handles designed for lifting and moving the battery when servicing.
- Early IMA systems also had contactors built into the battery junction board, but the Accord Hybrid has moved the contactors into the Power Control Unit.
- These contactors isolate the high voltage IMA battery from the rest of the IMA system.
- Since the contactors on the Accord Hybrid are outside the battery case, handle the battery leads as if they have high voltage power at all times. See the service manual for further information.

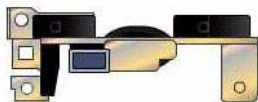
Contactors



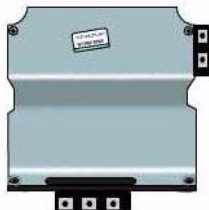
Handles



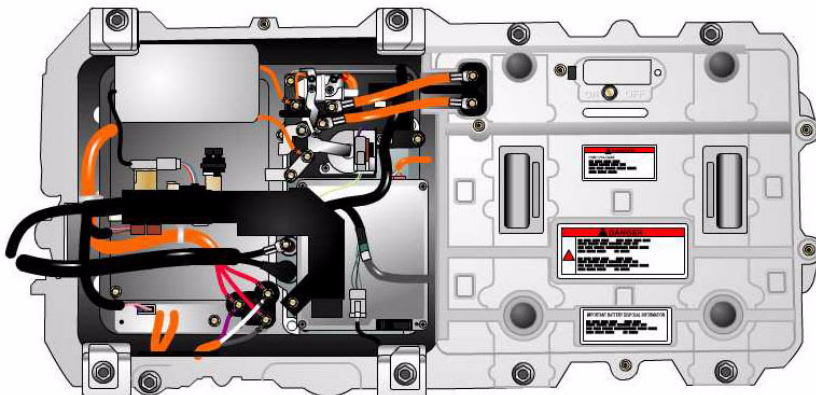
Capacitors



Current Sensor



Motor Power Inverter



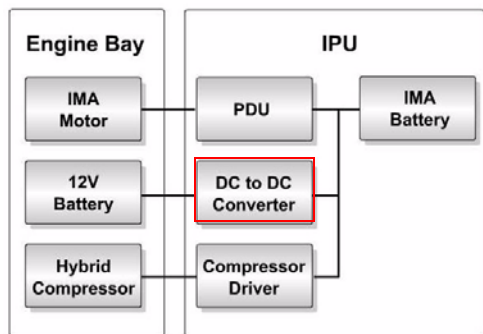
IMA Hardware

Power Drive Unit (PDU)

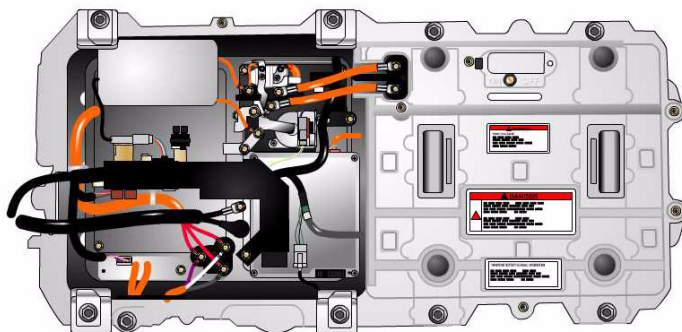
On Honda IMA systems, the Power Drive Unit includes capacitors, current sensors and the Motor Power Inverter module.

- The MPI contains solid state devices used to control the IMA motor.
- The Accord PDU has increased the efficiency and decreased in physical size compared to previous IMA vehicles.
- The new MPI module has the capacitors integrated into the module, and they can no longer be serviced separately.

IMA System



DC to DC Converter



IMA Hardware

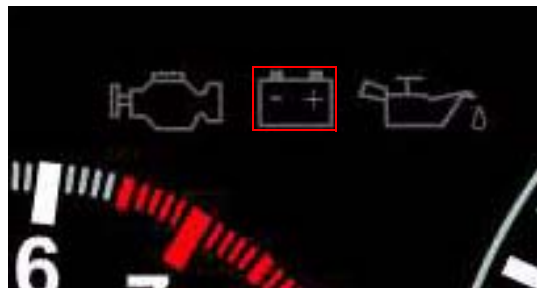
DC to DC Converter

The DC to DC converter is designed to provide twelve volt power to the vehicles twelve volt systems.

Because of this, the DC to DC converter functions as the alternator, replacing the traditional belt driven alternator.

If the DC to DC converter fails, the vehicle defaults to the twelve volt battery for twelve volt power, and the IMA system illuminates the red charge light on the instrument panel.

As with the PDU, the DC to DC converter has increased in efficiency while becoming smaller with each generation, and for the Accord Hybrid, has been changed from direct control to serial interface control.



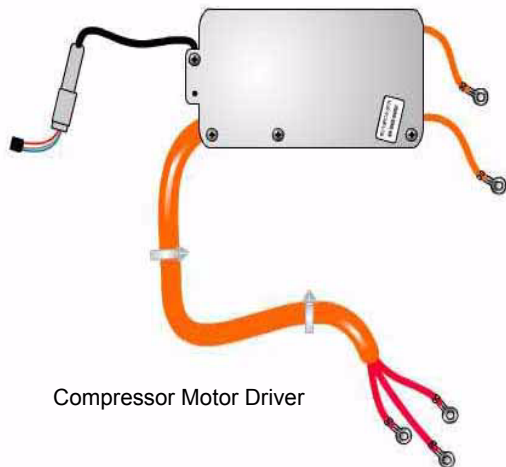
IMA Hardware

Compressor Motor Drive

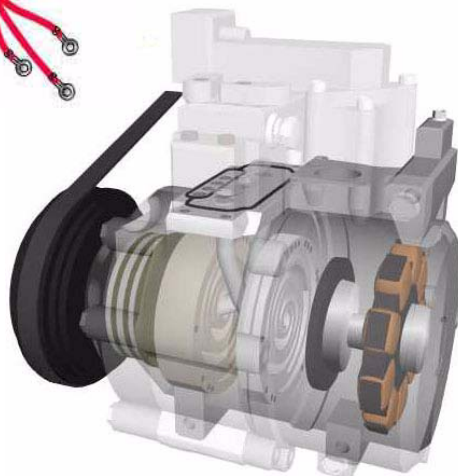
New to the Accord Hybrid, the compressor motor driver controls the rotation speed of the electric air conditioning compressor motor.

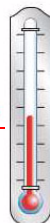
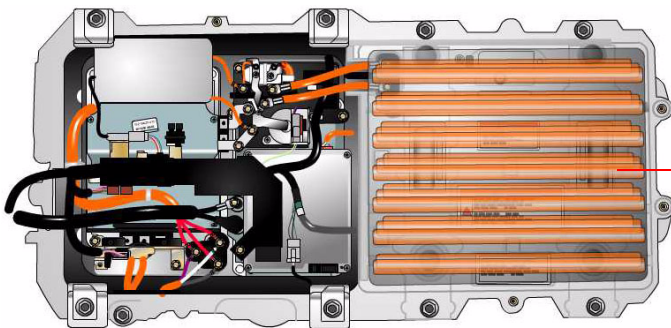
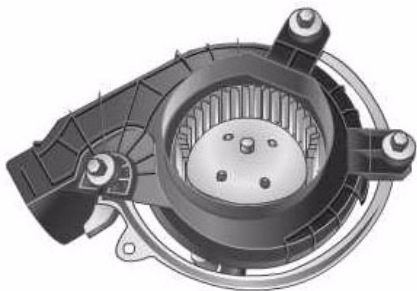
The driver provides three phase, high voltage power based on the speed requests made by the control system.

The electric air conditioning compressor motor must be powered by an electronic driver, since it is a smaller, lower powered version of the IMA motor.



Compressor Motor Driver





IMA Hardware

IPU Module Fan

Although not a high voltage system, the IPU module fan provides an important function.

The IPU cannot operate when too hot or too cold, so the module fan draws in climate controlled cabin air to help maintain moderate temperatures.

If the fan cannot warm or cool the IPU sufficiently, the IMA system may suspend charging and assist functions.

In order to closely control temperatures, the IPU module fan speed can be varied to meet system needs. The fan motor driver is mounted directly to the fan housing, and receives speed requests from the IMA control system.

Because this module uses serial data, fan operation cannot be tested using jumpers to the terminals.

See the service manual for specific diagnostic procedures.

Tech Note

Removing the IPU cover on Civic and Accord Hybrids prevents module fan airflow from reaching the battery. Because of this, the battery may overheat during extended operation.

The 12-volt started is used when any of these conditions are present:

Coolant Temperature	Below 5°F (-15°C)
IMA Battery Temperature	Below 16°F (-9°C)
IMA Battery Temperature	Above 138°F (59°C)
IMA Battery SOC	Below 23%
IMA Battery DTC	Present

Key Start Operation

In addition to the IMA motor, all Honda hybrids have a standard twelve volt battery and starter.

During key starts, the IMA system will evaluate conditions and determine which starter to use for initial start-up.

Engine starting using the twelve volt starter may occur during certain temperature conditions or during low IMA battery State of Charge, and is perfectly normal.

IMA system faults may also cause the the system to use the twelve volt starter, or the vehicle may use the twelve volt starter if the motor position sensor cannot initialize.

See the service section of this module for more information on motor position initialization.



Idle Stop and Start

Engine Idle Stop

The Honda IMA system is designed to suspend engine operation in order to save fuel and reduce emissions.

This mode is called Idle Stop, and occurs at low speeds once the car is warmed up and conditions allow the IMA system to safely shut off the engine.

Honda IMA equipped vehicles indicate the idle stop mode by flashing the words "AUTO STOP" in the meter.

When the IMA system flashes this icon in the meter, the vehicle is in normal idle stop and will restart automatically once the driver steps off the brake.

If the auto stop icon is not flashing, and the red charge and oil pressure lights are illuminated, the vehicle has stalled and must be restarted using a normal key start.

Idle Stop Enabling Conditions (must be present):

In D3/D5/N range.
After exceeding 9 mph (14 kph), then slowing below 10 mph (16 kph).
Throttle fully closed.
Brake applied.
Driveline in warm.
Battery state of charge is above 30%.
Adequate brake booster vacuum present.
PCM idle stop enable signal present.
Climate control idle stop enable signal present.
IMA battery temperature within limits.

Idle Stop

Idle Stop Condition

Each IMA equipped vehicle has specific idle stop conditions that must be present for Idle Stop to operate.

- These conditions also vary based on transmission type. Please refer to the service information for conditions required on any IMA vehicle you service.
- The main conditions used by the Accord Hybrid idle stop system are listed in the chart on the left.
- Notice that all IMA equipped vehicles monitor brake booster vacuum.
- If booster vacuum is not maintained, and all other conditions are correct, the engine will restart to maintain brake assistance.

Tech Note

Because of this, Honda hybrid vehicles have a brake booster pressure sensor installed in the vacuum line to the brake booster.

Idle Stop Enabling Restart Events:

After brake pedal release (brake SW OFF).

Shifting from N to R with the brake pedal depressed.

Pressing the accelerator pedal with the brake pedal depressed (for easy starting on an uphill slope).

When the vehicle speed sensor indicates motion.

When the master power brake vacuum is lost.

When the battery state of charge (SOC) drops under 25%.

When engine coolant temperature drops.

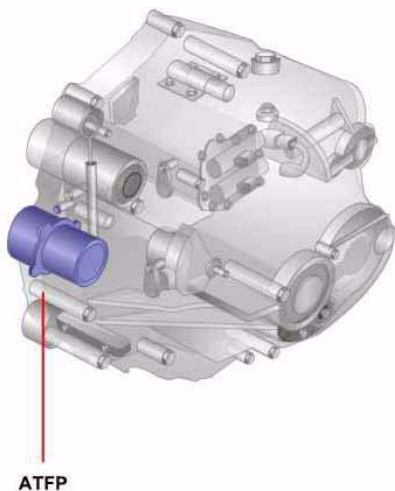
When IMA system requires IMA motor generation.

Idle Stop

Automatic Start

An automatic restart may occur if conditions require engine power.

- The primary reason for automatic restart occurs when the driver releases the brake pedal, but Idle Stop may end due to other conditions as well.
- When the IMA computer receives an engine start request from one of the other systems in the vehicle, it will start the engine.
- Restart may occur to power the vehicle's twelve volt system, or to prevent the vehicle from rolling down a hill.
- In addition, certain other conditions will end Idle Stop.
- For instance, the driver selecting reverse with the brake depressed, the hydraulic brake booster vacuum dropping below a threshold, or the engine coolant temperature significantly dropping will all cause auto start to occur.



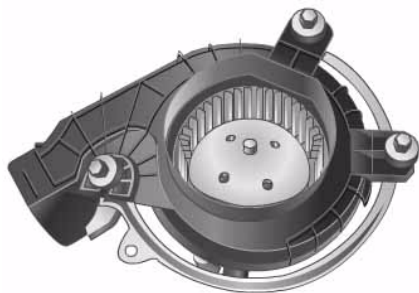
ATFP

Idle Stop

Auxiliary Transmission Fluid Pump

The Accord Hybrid includes one additional component to support vehicle restart.

- Because of the Accord Hybrid transmission design, hydraulic line pressure must be maintained during Idle Stop to insure the vehicle restarts without hesitation or jerking.
- To accomplish this, the five speed automatic transmission is equipped with an auxiliary transmission fluid pump.
- This pump is energized during idle stop, and replaces hydraulic pressure normally provided by the mechanical pump.
- The electric oil pump is a twelve volt brushless DC motor, and is driven by a motor controller located at the left front strut tower.
- Based on electrical draw, the controller measures motor torque, and maintains line pressure based on this measurement.

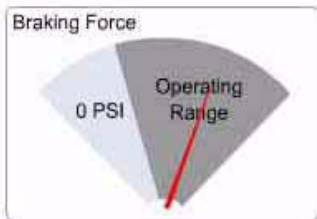


Idle Stop

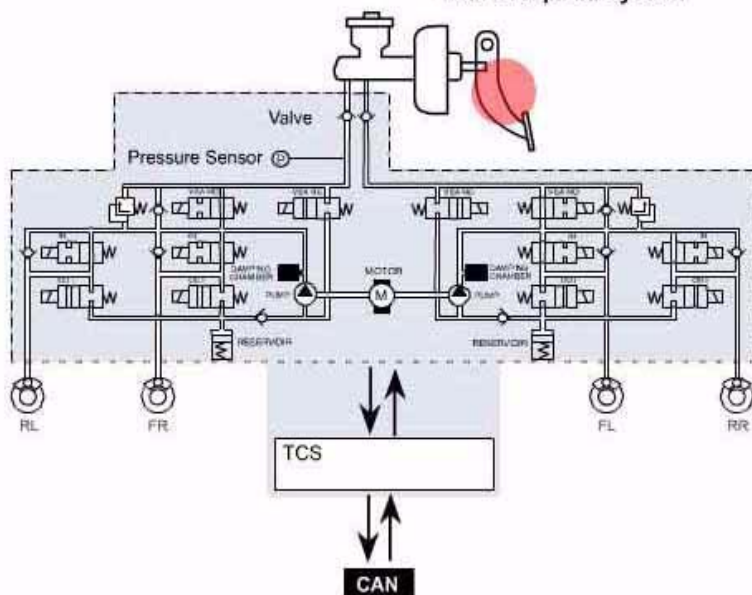
Brushless DC Motors

There are several brushless DC motors on the Accord Hybrid, using both high and low voltage.

- These include the IMA motor, auxiliary transmission fluid pump, IPU cooling fan, and Hybrid compressor motor.
- These motors must be driven using a solid state controller, and cannot be run or tested simply by applying twelve volts to the motor leads.
- To test the auxiliary transmission fluid pump, you must command the pump on using the HDS.
- Please refer to the vehicle service information for detailed instructions.



With Creep Aid System



Section Heading

Creep Aid System (CAS)

To reduce vehicle rollback when starting on a hill, Honda IMA equipped vehicles include a Creep Aid System.

- The system briefly maintains braking force when the driver's foot releases the brake pedal and moves to the accelerator.
- By holding brake pressure after pedal release, the vehicle is briefly held in place while the engine starts and before the car begins forward motion.
- Unlike previous Hondas, the Accord Hybrid has incorporated CAS into the Traction Control System.
- This reduces brake system complexity, and increases the level of CAS control.



Climate Control

Like previous IMA equipped vehicles, the Accord climate control system has the ability to inhibit the idle stop function.

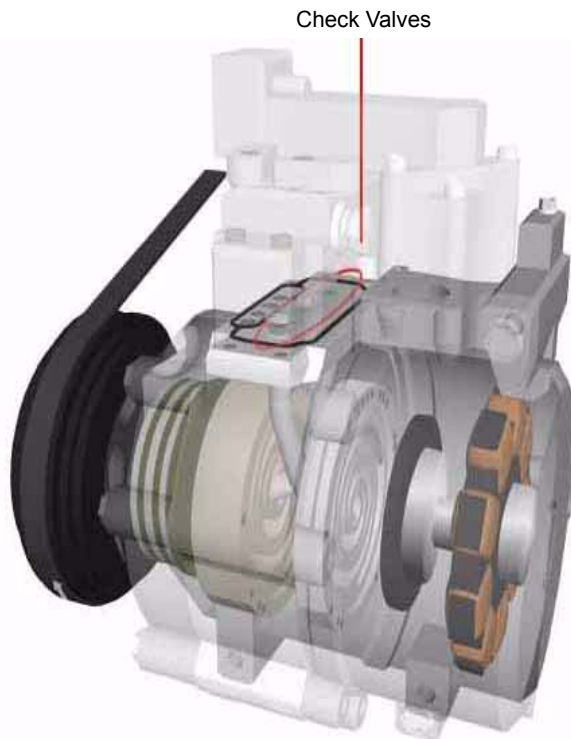
On earlier Honda IMA vehicles, activating the climate control would prevent idle stop.

On the other hand, if the economy button was pressed to allow idle stop, climate control functions ceased during idle stop.

In other words, the driver had a choice: Idle stop or climate control, but not both.

In the Accord Hybrid, components have been put in place to allow both cabin heating and cooling during idle stop.

By using electrical energy stored in the high voltage battery, both heating and air conditioning can continue even without the engine running.



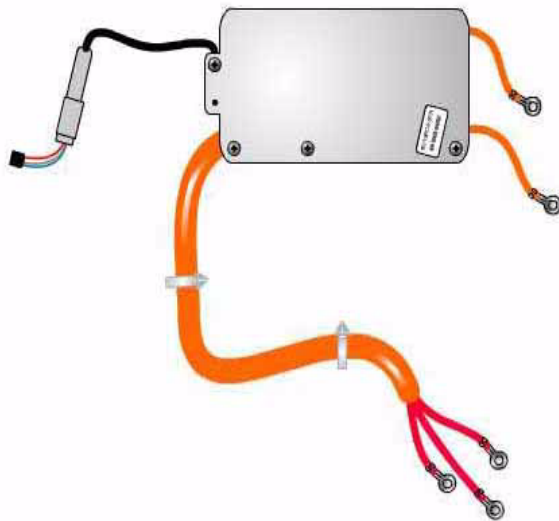
Check Valves

Climate Control

Hybrid Compressor

As we shown in the hardware section, the Accord Hybrid uses a new hybrid compressor.

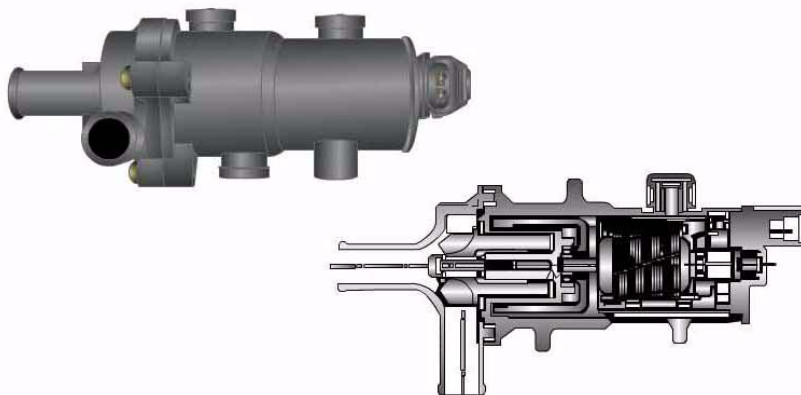
- This dual type compressor includes an engine powered compressor and an electric motor driven compressor in the same case.
- The compressors share a common inlet and outlet, and have check valves to isolate the high pressure side of each compressor.
- The two compressors also have separate shafts which share the same axis, but do not interconnect.
- Because of this, the engine driven compressor and the electrically driven compressor can operate either together or independently.
- This allows the vehicle control system to choose the compressor drive method which best meets system needs.
- During operation, the compressor driver varies motor speed between zero and five hundred R-P-M.



Climate Control

Hybrid Compressor Motor Driver

During operation, the hybrid compressor motor driver sets the motor speed based on commands provided by the IMA control system.



Climate Control

12-Volt Cooling Pump

As a new feature, the Accord Hybrid has a twelve volt coolant pump added to the heater system.

- This pump helps to maintain cabin heat during idle stop.
- The pump is controlled by the climate control module, and is a twelve volt single speed DC motor.
- Therefore, it can be tested by applying twelve volt power at the motor connection.

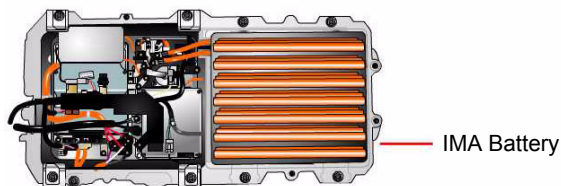


Climate Control

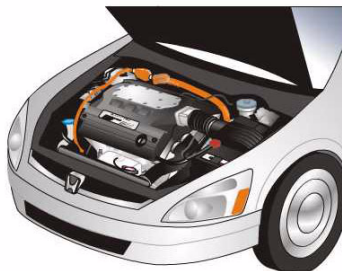
Idle Stop

As shown in the idle stop section, during long idle stop periods the IMA system may restart the engine to maintain engine temperature or system voltage.

- The climate control system drains energy from both the IMA battery and the engine water jacket.
- Therefore, during high demand conditions, engine restart may frequently occur during idle stop even when the driver has not stepped off the brake pedal.



IMA Battery

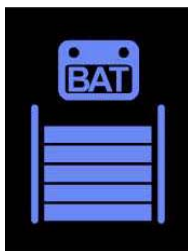


Service Issues

High Voltage Service

Remember, all Honda systems using a high voltage distribution system identify the presence of high voltage by using orange colored cables and covers.

- Honda high voltage systems have two separate potential sources of high voltage, the IMA battery and the IMA motor.
- Even with the IPU disconnected, the IMA motor may create high voltage if the rotor is turning.
- Therefore, make sure the battery is isolated, and the vehicle engine is off whenever working with the high voltage system.
- See the service manual for further information.
- In addition, make sure to wait five minutes after switching the key off, in order for the IMA system capacitors to discharge.
- As always, please follow service manual recommendations when working with high voltage systems.



Service Issues

Battery State of Charge Indicator

The state of charge indicator provides a calculated value to indicate the potential battery energy.

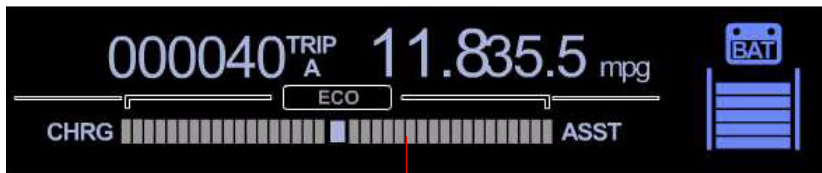
Because of its calculated nature, the value may not reflect actual battery State of Charge, since it is subject to accumulated measurement errors, and is stored in volatile memory.

When servicing an IMA equipped vehicle, any loss of high voltage power will erase the calculated value for the IMA battery state of charge.

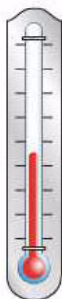
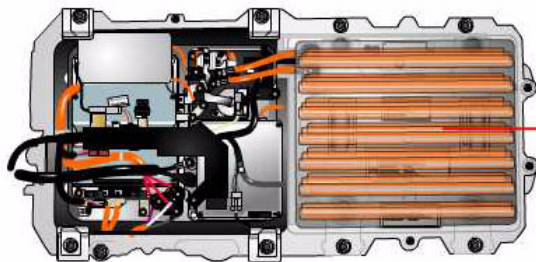
If this occurs, the indicator display will change.

To reset the indicator, start the engine, place the car in Park, and hold the engine at thirty five hundred RPM until the indicator displays a sufficient charge.

If conditions are correct for normal operation, the system should reflect a charge value within ten minutes.



No Assist



Service Issues

Assist Disablement

During vehicle operation if the IMA battery state of charge drops or the battery temperature becomes extremely low or high, the charge and assist functions will be suspended.

While this is a normal condition, there is no indicator to inform the driver that the IMA system has temporarily suspended operation.

In some cases, there will be a low State of Charge indication, but when battery temperatures move outside the normal limits, the battery may indicate a high State of charge, even while IMA functions are suspended.

While the driver may not notice the system is no longer charging, during these conditions there will be no acceleration assist, and the driver will notice the reduced power.

Keep this in mind when diagnosing intermittent power loss complaints, and confirm that the complaint does not reflect extreme operating conditions, rather than system malfunction.



Service Issues

Start/Charging System

When servicing an IMA equipped vehicle, diagnosing the starting and charging system requires special procedures.

- For instance, since the vehicle does not have an alternator, some automated testers such as the Bear battery charging and starting system tester, will fail a properly functioning system.
- The DC to DC converter can be tested for output, but be sure to measure amperage using the lead running from the DC to DC converter to the under hood fuse box.
- See the applicable service manual for further information on system testing.

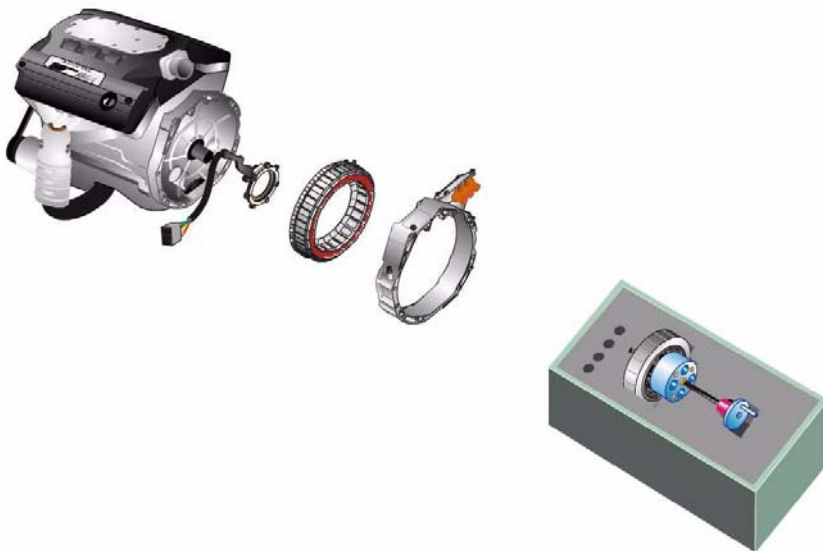


Service Issues

Air Conditioning Service

Due to the unique operating requirements of the hybrid compressor, a special compressor oil has been specified.

The high voltage motor within the hybrid compressor will not work with standard compressor oils, so any service work requiring compressor oil replacement must be performed using the correct compressor oil specified for use in hybrid compressors.



Service Issues

Rotor Removal and Installation

Rotor removal or installation on any IMA motor requires using the correct rotor puller.

If the rotor is installed without using the correct puller, it may suddenly be pulled toward the stator with great force, which could potentially cause a hand injury.

For safe handling, place the rotor in the space provided in the tool storage box. In this way, the rotor's magnetic field will not attract stray parts, or suddenly draw itself to magnetically attractive surfaces.

In addition, the storage box holds the rotor securely, and can help when mounting or dismounting the service tool onto the rotor.

Magnets may become demagnetized when exposed to excessive heat or impact. Because of this, use care to avoid dropping or damaging the rotor.

Refer to the service manual for specific information on rotor removal procedures.



Service Issues

Anytime removal or replacement of the IMA stator, rotor, or position sensor occurs, or the IMA motor controller is replaced, the Motor Position Sensor Initialization Procedure must be performed, using the HDS.

This procedure allows the IMA system to compensate for any minor variation in motor or sensor mounting position.

Failure to perform the initialization procedure may cause the vehicle to start using the twelve volt starter, even when conditions are correct for IMA motor starting.



HDS Service Functions



Summary

You Should Now Be Able to:

- Match IMA components with their related function in Hybrid vehicles.
- Identify IMA components used in Hybrid vehicles.
- Determine when the twelve-volt starter or IMA is used to start the engine.
- Predict IMA operation for various vehicle operating conditions.
- Identify climate control components of the Accord Hybrid.
- Select the correct service procedures for IMA systems and components.

Training Center Note

This knowledge module is a prerequisite to a skill, or "hands-on," module you will take at your Training Center. Before starting that skill module, you will be asked by your instructor to validate your knowledge on the subject of this module. We suggest that you review the content prior to your arrival at the Training Center.

